Efficiency of Flossing Technique Application among Dental Students at Riyadh Elm University, Riyadh, Kingdom of Saudi Arabia

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ABSTRACT

Aim: To evaluate the students' efficiency of flossing theoretically and mechanically.

Materials and methods: Disclosing solution was used to detect the plaque clinically following the plaque index by Silness and Loe. The clinical examination was done three times, once before any oral hygiene measure, then after brushing with a toothbrush only and finally after flossing. Each participant filled a questionnaire on their oral hygiene habits, knowledge of flossing importance and their protocol for dealing with their patients' oral hygiene.

Results: A group of 84% of the students use the dental, 52% had the dental floss recommended to them by a dentist, 77% believe that the dental floss does not harm the teeth and gingiva, and 79% believe that neglecting to floss can lead to the development of both dental caries and periodontal diseases. Only 50% of the students educate all their patients on flossing, and the majority do it by a demonstration on a plastic jaw or verbally only. The examinations revealed that a mean of 68% plaque was found on the teeth before any oral hygiene measure with the majority being grade II, a mean of 33.53% was found after brushing only with the majority being grade I and a mean of 10.82% was found after flossing with the majority being grade I as well. Only 39% of the students were able to achieve complete plaque removal, and the posterior areas had the highest percentages of persisted plaque after flossing.

Conclusion: The students' flossing technique needs to be emphasized during their education, alongside the importance of educating all the patients on flossing and monitoring their efficiency throughout the treatment and maintenance visits.

Clinical significance: Students need to be able to floss their teeth efficiently to transport that knowledge to their patients and follow-up its application throughout the visits.

Keywords: Education, Efficiency, Flossing, Hygiene, Student.

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INTRODUCTION

It is documented in the literature that the behavior of oral health providers toward their oral health reflects their understanding of the importance of preventive dental procedures and the oral hygiene regimen, and of improving the overall oral health of their patients.¹ Promoting oral health via patients' education is a key point of the dental students' education as it improves the overall compliance in the communities,² and being efficient in their own oral hygiene can reflect positively on their ability to motivate and educate the patients.³

The main objective of the oral hygiene is to remove the dental plaque, which is defined as a soft deposit that forms the biofilm adhering to the tooth surface or other hard surfaces in the oral cavity including removable or fixed restorations.⁴ It is composed primarily of microorganisms and is visualized on the teeth after 1–2 days of no hygiene measures.^{5,6} And it is considered an essential factor in the development of dental calculus which in itself is a hard deposit that forms by the mineralization of dental plaque and is covered by a layer of unmineralized dental plaque. Dental plaque and calculus are the major etiological factors in the initiation and progression of periodontal diseases.⁷

Daily toothbrushing and flossing are easy, effective and low-cost practices for removing the microbial dental plaque.⁸ Mechanical plaque control is the daily cleaning with a toothbrush and other oral hygiene aids such as dental flosses, interdental brushes, toothpicks, oral irrigators, and others. The effectiveness of self-care mechanical

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plaque control depends on the motivation and knowledge of proper oral hygiene protocols.

Any toothbrush despite the used method, size, design, and bristle hardness does not completely remove the interdental plaque in individuals with healthy periodontal conditions nor in those with open embrasures as a result of lost periodontal support.^{9–11}

Dental floss is the most widely recommended aid for removing dental plaque from proximal tooth surfaces.⁹ There are many types of dental flosses commercially available with parallel proficiencies, as clinical researches have demonstrated no significant differences in the ability of the different types to remove dental plaque interproximally.¹²

The flossing technique is the key point of the proximal surfaces cleaning, as the floss must contact the proximal surface from line angle to line angle to achieve effective cleaning. It must also clean the entire proximal surfaces of the teeth, not just be slipped apical into the contact areas.¹³

In the controlled and supervised environment of clinical research, where well-trained individuals remove all visible plaque, gingival health can be maintained by one thorough cleaning with a brush, floss, and toothpicks every 24–48 hours. It has been reported that improved plaque removal, and therefore improved periodontal health, is associated with increasing the frequency of brushing to twice per day.¹⁴ Therefore, cleaning three times per day or more does not appear to improve periodontal conditions further.

One of the educational and motivational tools to determine and improve the efficiency of the dental plaque control is the disclosing agent, which is a solution or tablets that is used to reveal or detect the bacterial plaque deposit on the teeth, gingiva and the tongue.¹⁵ The solution is applied on the teeth by cotton swabs or diluted as rinses which can produce heavy staining of bacterial plaque on the teeth, gingiva and tongue, both forms are used as a tool to measure the oral hygiene efficiency at the dental clinic or at home.¹³

This study aims to evaluate the level of knowledge and efficiency of the undergraduate dental students toward the oral health behavior, oral hygiene and mechanical plaque control using dental floss in Riyadh Elm University Dental Hospital.

MATERIALS AND METHODS

The study was approved by the Institutional Review Board of Riyadh Elm University (REU). A cross-sectional observational study was conducted at the University Dental Clinics affiliated to the faculty of dentistry of REU in Riyadh, Saudi Arabia.

The questionnaire was designed to collect data on the student's personal oral hygiene experiences with an emphasis on flossing. The questionnaire consists of sixteen close-ended questions (multiple-choice questions) divided into two parts; the first part contained three questions regarding personal information of the participant, the second part was composed of thirteen questions to assess the knowledge and attitude in general of the oral health behavior, oral hygiene and mechanical plaque control using cleaning aids, and their impact on oral health. In the second part, five questions were used to assess the level of frequency of oral hygiene activity, the use of the interdental cleaning aids, and to assess the attitude toward using the dental floss. Two questions were used to evaluate the participants social environment effects toward oral hygiene protocol, and six questions were used to evaluate the participants knowledge toward flossing's impact on the oral health, and to assess their attitude toward their patients' education on the effect of flossing.

Test subjects were randomly selected using the convenience sampling method, the sample size was 100 dental students. All the participants consented by signing a paper-based consent form prior to any examination. Data were collected through a validated, self-administered questionnaire, and the clinical examination utilized the established plaque index¹⁶ via the application of disclosing agent tablets "each tablet consisted of 5 mg (1.36%) erythrosine (FD and C red coloring agent), 2 mg (0.54%) mint oil and excipient ad 360 mg," where the grade 0 index means there's no dental plaque, grade I index means that dental plaque can't be visualized but is detected after the application of the disclosing solution. Grade II index means that dental plaque is easily visualized by the naked eye without the use of the disclosing solution but not exceeding

one third of the tooth surfaces, and finally grade III index means there's an abundance of dental plaque covering more than third of the tooth surfaces. The recordings of the dental plaque index to measure the state of oral hygiene was done at three intervals; once at the baseline before any oral hygiene method, then after brushing only and finally after flossing. Each student was asked to brush using a medium hardness toothbrush and an over-the-counter fluoridated toothpaste for 2 minutes using the bass technique and then was asked to floss using a nonwaxed dental floss for 2 minutes.

The study subjects consisted of undergraduate dental students in their 4th, 5th and 6th year of dental school. Any participants who were actively undergoing orthodontic treatment were excluded, and all the third molars were excluded as well.

As a pilot study to measure the reliability of the proposed methodology and to measure the intraexaminer and the interexaminer reliability of the collected data, readings following the described outlines for 5 students were taken before the data collection step by two examiners and then taken again after 1 week, then Cohen's Kappa test was used to measure the agreement between the readings. The values for the various readings ranged between 0.84 and 0.90, which is interpreted as a "very good" strength of agreement,¹⁷ and an "almost perfect agreement."¹⁸

SPSS™ version 22 and Microsoft Excel™ were used to perform the statistical test on the data. Descriptive statistics were used to summarize all variables and presented as means, modes and percentages. Predictors of knowledge and associations were tested using SPSS™ version 22 via the independent *t* test, paired *t* test, Chi-squared test and ANOVA. Values were considered statistically significant when *p* value was < 0.05.

RESULTS

The study included 100 students attending the Riyadh Elm University from the 4th, 5th and 6th years of the dental school. The mean age of the participants was 24 (± 1.58) years old. When asked about their oral hygiene regimen, 52% of the students brush their teeth twice daily, 35% brush only once daily, 5% brush more than twice daily, 7% answered that they do not brush daily and 1% never brush their teeth. As for the flossing frequency, the majority at 52% floss their teeth but not daily, 26% and 5% floss twice daily and once daily, respectively, 16% never floss and only 1% floss more than twice daily (Fig. 1). The time of flossing was separate from

Fig. 1: Students' brushing and flossing frequency

toothbrushing for 39% of the students, 33% floss after brushing and 28% floss before it. When asked about extra-aids used to maintain their oral health, 14% answered that they use mouthwash rinses, 4% use toothpicks and 5% use a water jet dental floss.

About 77% believe that the dental floss does not harm the teeth and gingiva, while 18% believe that it does. When asked about their first exposure to a dental floss, 52% had it recommended to them by a dentist, 11% by a parent and 2% by a friend, while 14% and 8% got their knowledge from a university professor or an oral hygiene educational guide, and 13% educated themselves on dental flosses. As to the importance of flossing in the daily oral hygiene regimen, 13% believe that neglecting to floss can lead to the development of dental caries only, and 8% believe that it can lead to periodontal diseases only, while 79% believe that neglecting to floss can lead to the development of both dental caries and periodontal diseases. As for why patients might neglect to use a dental floss, 39% think it is due to not knowing how to use it, 29% think it is due to lack of time, 19% think it is because they use a toothpick instead, 12% think that a dental floss is difficult to use, and only 1% think that it is considered expensive by the patients (Table 1).

Asking the students about how they handle the topic of teeth flossing with their patients revealed that 50% only educate all their patients on the proper way of using a dental floss, 17% only educate high caries risk patients, 7% only educate periodontally compromised patients, and 26% don't educate their patients at all. As for the method, most used by the student in educating the patients on flossing; 28% prefer to use the plastic jaw model, 26% give the instructions verbally only, 10% and 1% do the demonstration on the patients' teeth or their own teeth,

respectively, and 8% show an instructional video to the patients. Moreover, assessing the efficiency of the patients flossing in the reevaluation and maintenance visits is done by 33% of the students for all the patients, 15% and 10% do it only for high caries risk and for periodontally compromised patients, respectively, while 42% do not do it at all (Table 1).

The clinical examination of the students at baseline before any oral hygiene measure showed that 68% ($\pm 23.78\%$) of the examined teeth surfaces had dental plaque deposits with the majority (62%) having a grade II plaque index, with the interproximal areas of the posterior teeth having the highest percentages (83–92%). After the students only brushed their teeth using a toothbrush and toothpaste, the examination showed that 33.53% ($\pm 20.7\%$) of the teeth surfaces had plaque deposits with the majority (72%) having a grade I plaque index, with the interproximal areas of the posterior teeth having the highest percentages (53–79%). And finally, after the students flossed their teeth, the examination showed that 10.82% ($\pm 15.94\%$) of the teeth surfaces had plaque deposits with the majority (54%) having a grade I plaque index, with the interproximal areas of the posterior teeth also having the highest percentages (14–40%). Moreover, in all the three examinations, the interproximal areas of the lower right second molar (#47) had the highest percentages of plaque deposits at 92%, 79% and 40%, respectively (Tables 2 and 3; and Fig. 2).

Comparing the percentages of the three clinical examinations revealed the size of the difference (t value) between the percentages at baseline and after brushing only to be 19.137 with the mean difference being 34.46% ($\pm 18.01\%$), also the t value comparing the baseline and after flossing was 23.737 with the mean difference

Table 1: Students' dental flossing knowledge and patients' education protocols

Is the use of dental floss harmful to the teeth and gingiva?					
Yes	18%	No	77%	I do not know	5%
Who did recommend the dental floss to you?					
Dentist	Friends	Parents	University professor	Oral hygiene education guides	No one
52%	2%	11%	14%	8%	13%
What diseases can be caused by non-flossing ?					
Dental caries	13%	Periodontal diseases	8%	Both	79%
Why do you think some patients do not use dental floss?					
It is difficult to use	They do not know how to use it	They do not have time	It is expensive	They use a toothpick instead	
12%	39%	29%	1%	19%	
Do you teach all your patients how to use the dental floss?					
Yes	No	High caries risk patients only		Periodontally compromised patients only	
50%	26%	26%		7%	
What is your most used method to educate the patients on flossing?					
Verbally only	On the plastic model	Demonstration on their teeth	Demonstration on my teeth	Showing a video on flossing	I do not educate them
26%	28%	10%	1%	8%	26%
Do you check the flossing efficiency of the patients in the reevaluation and maintenance visits?					
Yes	No	High caries risk patients only		Periodontally compromised patients only	
33%	42%	15%		10%	

Table 2: Comparing the different means in the three clinical examinations

	Mean (%)	Std. deviation (%)	Minimum (%)	Maximum (%)
Baseline examination	68	23.78879	3.57	100
After brushing only examination	33.5357	20.70318	0	91.07
After flossing examination	10.8214	15.94329	0	80.36

	Mean	Std. deviation	t	df	Sig.
Comparing baseline examination and after brushing only examination	34.46429	18.00891	19.137	99	0.000
Comparing the baseline examination and after flossing examination	57.17857	24.08790	23.737	99	0.000
Comparing after brushing only examination and after flossing examination	22.71429	16.31525	13.922	99	0.000

being 57.18% ($\pm 24.09\%$), and finally the *t* value comparing the after brushing only exam and after flossing exam was 13.922 with the mean difference being 22.71% ($\pm 16.32\%$). With all the differences between the three clinical examinations they are statistically significant ($p < 0.05$) (Table 2). When the student's year in dental school was focused on, it showed that the 5th year students had

Fig. 2: Plaque index grades' distribution in the three clinical examinations

Table 3: Distribution of plaque deposits on teeth surfaces

At baseline		After brushing only		After flossing	
Teeth and surfaces	Percentage	Teeth and surfaces	Percentage	Teeth and surfaces	Percentage
47MD	92	47MD	79	47MD	40
35MD	90	46MD	75	17MD	39
37MD	89	37MD	72	46MD	35
45MD	89	45MD	72	27MD	34
46MD	89	26MD	70	37MD	34
26MD	88	27MD	70	36MD	32
27MD	88	36MD	67	16MD	27
15MD	87	17MD	66	45MD	25
25MD	87	16MD	66	26MD	21
16MD	86	15MD	66	15MD	19
17MD	85	35MD	64	35MD	18
36MD	84	25MD	62	44MD	15
24MD	83	24MD	59	25MD	14
37BLO	82	14MD	58	37BLO	10
34MD	80	34MD	54	46BLO	10
47BLO	79	44MD	53	14MD	9
36BLO	78	21MD	46	12MD	9
14MD	77	23MD	46	21MD	9
35BLO	77	11MD	44	36BLO	9
44MD	77	22MD	44	35BLO	9
46BLO	77	12MD	43	43MD	9
16BLO	76	13MD	42	47BLO	9
27BLO	75	33MD	36	16BLO	8
23MD	74	43MD	36	11MD	8
17BLO	73	42MD	33	22MD	8
22MD	73	41MD	32	23MD	8
45BLO	73	32MD	31	24MD	8
12MD	72	31MD	30	42MD	8

MD, mesial and distal; BLO, buccal, lingual/palatal and occlusal

the least amount of plaque after flossing at 8.16% ($\pm 11.33\%$) and it was a statistically significant difference ($p < 0.05$) compared with the 4th year students at 14.73% ($\pm 18.81\%$) and the 6th year students at 11.52% ($\pm 18.13\%$). And the 6th year students had fewer amounts of dental plaque after flossing compared with the 4th year students but it wasn't statistically significant ($p > 0.05$).

The percentages of dental plaque deposits of the after brushing only exam of the students that routinely floss their teeth was 27.22% ($\pm 18.91\%$) and of the ones that don't was 42.96% (± 13.22), and comparing them yielded a t value of -3.095 and a mean difference of -15.74% ($\pm 5.09\%$) with the difference being statistically significant ($p < 0.05$). Also, a statistically significant difference ($p < 0.5$) was found in comparing the percentages of dental plaque deposits of the after flossing exam between the students that routinely floss their teeth at 7.44% ($\pm 13.22\%$) and the ones that don't at 14.96% (± 18.04) with a t value of -2.404 and a mean difference of -7.52% ($\pm 3.13\%$). Relating the percentages of the dental plaque deposits of the after brushing only exam and after flossing exam with various groups showed that between all the academic groups, the other oral hygiene regimen groups and the patient management protocol groups there was no statistically significant differences ($p > 0.05$).

DISCUSSION

The use of dental floss dates back to prehistoric times, and the credit of inventing the modern dental floss goes to Levi Spear Parmly, a dentist from New Orleans, fondly referred to as the apostle of oral hygiene.¹⁹ The use of dental floss alongside regular toothbrushing has been recommended routinely for the prevention against interproximal dental caries and gingival diseases, and several studies have reported that flossing improves periodontal indices.^{20–22}

In this study, the main objective was to analyze the effectiveness of flossing amongst the dental students, the gender of the participant was found to be irrelevant to the findings in such studies.² Several studies have reported that dental health attitudes are more positive and are improved as the level of education increases^{23–25} which was similar to this study. On comparing the 4th and 5th year students, the 6th year students had more plaque compared to the 5th year students, which points out the fact that the level of education being a factor but not a major one in the flossing efficiency.

The majority of the participants answered that the use of dental floss has been recommended to them by their dentists, which highlights the critical role of the dentists in promoting and enhancing the oral health in their communities, and that is supported by the findings of a study on the Swedish population²⁰ where it pointed out the importance of oral education individually on patient-specific bases.

Comparing the oral hygiene protocols of the participants, the results on the toothbrush use was similar to the data reported by a study on the dental students at Rural Dental College, Loni in India²⁶ as the two highest answers in both studies were brushing twice daily and once daily, respectively, as for the flossing in this study; 84% of the participant use the floss but the majority (52%) don't use it daily, which is a much higher percentage compared to the findings of study in India²⁶ where it was reported that only 13% of the students use the floss with an additional 7% using the interdental brush, but the opposite was true for the use of mouthwash where only 14% of the participants in this study use it while 73% of use was reported by the afore mentioned study.²⁶

Comparing the percentages of the after brushing only exam and after flossing exam showed that a statistically significant dental plaque reduction occurred between the groups, which reemphasizes the importance of flossing in the dental plaque removal interproximally falling in line with the findings of multiple reports.^{20–22} But the fact that a mean of 10.82% of dental plaque persisted after brushing and flossing and only 39% of the students achieved 100% dental plaque removal points out a deficiency in the students flossing efficiency especially in the posterior teeth as the majority of the persisted dental plaque was in the interproximal areas of the 2nd and 1st molars alongside the 1st and 2nd premolars.

A clinical trial on the sequence of toothbrushing and flossing²⁷ found that the best sequence between flossing and brushing is to start with flossing to loosen the dental plaque and then to brush it, which in amongst this study's participants was the least method followed in their daily oral hygiene regimen at 28%, while the highest response was that flossing was separate from brushing.

The data showed that the students emphasize the importance of flossing for the patients at the initial visit but the majority neglect to check its efficiency at the reevaluation and maintenance visits, and it is stated in the literature that the oral hygiene protocol needs to be reassessed and reinforced as a whole during the maintenance visits.²⁸

CONCLUSION

The dental plaque scores were significantly lower after the students flossed their teeth, but only 39% of the students were able to achieve complete plaque removal, and the posterior areas had the highest percentages of persisted dental plaque after flossing. The students' flossing technique needs to be emphasized during their education, alongside the importance of educating all the patients on flossing and monitoring their efficiency throughout the treatment and maintenance visits.

CLINICAL SIGNIFICANCE

Flossing is an essential part of the daily oral hygiene regimen, and the role of the dentists in educating their patients on it is significant. Therefore, students need to be able to floss their teeth efficiently to transport that knowledge to their patients and follow-up its application throughout the visits.

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